$2.50

Simpson®

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

SIMPSON 360-2
DIGITAL VOLT-OHM-MILLIAMMETER

WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

SIMPSON ELECTRIC COMPANY
A Katy Industries Subsidiary
853 Dundee Avenue, Elgin, Illinois 60120
(312) 697-2260 • Cable SIMELCO • Telex 72-2416
IN CANADA: Bach-Simpson, Ltd., London, Ontario
IN ENGLAND: Bach-Simpson (U.K.) Ltd., Wadebridge, Cornwall

Warranty

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

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Figure 1-1. Simpson 360-2 Digital Volt-Ohm-Milliammeter

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WARNING

The Simpson 360-2 is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

SECTION I

INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 360-2 Digital Volt-Ohm-Milliammeter is a compact, 3-1/2 digit instrument, suitable for both field and bench use in general electronic maintenance, production, and laboratory. It features 0.25% accuracy, solid state integrated circuit electronics, AC line and self-contained battery operation, and LED display. Additional features are automatic polarity, excellent temperature and overranging characteristics, analog indication, and analog (recorder) output.

1.1.2 The 360-2 measures DC voltage, AC voltage, DC and AC current and resistance as specified in Table 1-1. The up-down integration technique is used for the analog-to-digital conversion, because of its inherently excellent stability, accuracy, and noise immunity. The use of an MOS-LSI integrated circuit achieves high reliability, low power dissipation, and a compact design.

1.1.3 The Simpson 360-2 is supplied with a standard AC adapter/charger for 120 VAC, 50-400 Hz operation. A 220V AC adapter/charger is available as an option. For applications requiring complete isolation from the power line, or when the AC line is not available, battery operation is provided using rechargeable, nickel-cadmium cells. The battery can operate the Instrument for 8 hours continuously. Recharging is automatic when the Instrument is in the BATT CHRG ONLY position, and with the AC adapter/charger connected. In an emergency, commercially available, "C" size (flashlight type) batteries can be used (refer to Section IV for precautions and instructions).

1.1.4 The numerical display is a 7-segment light-emitting-diode (LED) for easy viewing and solid-state reliability. The numerals are 0.43 inch high and in a single plane for distant and wide-angle viewing. Ambient lighting effects are minimized by a filter which reduces reflections and background illumination.

1.1.5 Two "low power" resistance measuring ranges, which feature a maximum full-scale voltage of 200 millivolts, are provided. These ranges are useful in making resistance measurements in circuits containing semiconductor devices. The low full-scale voltage allows "in circuit" resistance measurement without the "turn-on" of most semiconductor junctions.

1.1.6 The recorder output provision makes it possible to record low level high impedance voltage sources using a non-potentiometric recorder.

1.1.7 The analog meter provides quick and convenient indications for nulling, peaking, scanning and varying signal applications.

1.2 ACCESSORIES AND SUPPLIES

All supplies and accessories required for the operation of the Instrument (using line power) are furnished with the Instrument and listed in Table 7-1. Batteries are not supplied.

1.3 TECHNICAL DATA

Table 1-1 lists the technical specifications for the Simpson 360-2 Digital Volt-Ohm-Milliammeter.

Table 1-1. Technical Data

1. DC VOLTAGE:

Range	Maximum Indication	Input Resistance	Overload Protected To
200 mV	±199.9 mV	10 MΩ	±350 V
2 V	±1.999 V	10 MΩ	±350 V
20 V	±19.99 V	10 MΩ	±1100 V
200V	±199.9 V	10 MΩ	±1100 V
1000 V	±1000 V (max. input)	10 MΩ	±1100 V

Accuracy: (from +15°C to +35°C)	± (0.25% of reading + 1 digit)
Input Bias Current:	7 nA maximum at reference conditions
Sensitivity:	100 microvolts on 200 mV range
Overrange Capability:	Linear to 500 counts beyond maximum indication (except on 1000 V range, where any indication greater than 1100 is an overload)
Temperature Coefficient: (from 0°C to +50°C)	± (0.025% of reading + 0.1 digit)/°C
Full Scale Step Response: (to within rated accuracy)	1 second
Normal Mode Rejection:	35 dB minimum at 60 Hz
Common Mode Rejection:	80 dB minimum at 60 Hz with 1000 Ω unbalance 100 dB minimum at DC with 1000 Ω unbalance

2. RESISTANCE:

Range	Maximum Indication	Test Current	Full Scale Voltage	Overload Protected To
200 Ω	199.9 Ω	1 mA	200 mV	*150 V rms
2 kΩ	1.999 kΩ	1 mA	2 V	*150 V rms
20 kΩ	19.99 kΩ	10 μA	200 mV	250 V rms
200 kΩ	199.9 kΩ	10 μA	2 V	250 V rms
2 MΩ	1.999 MΩ	1 μA	2 V	250 V rms
20 MΩ	19.99 MΩ	100 nA	2 V	250 V rms

*Fuse Protected

Accuracy: (from +15°C to +35°C)	± (0.5% of reading + 1 digit), except on 2MΩ and 20 MΩ ranges, which are ± (1% of reading + 2 digits)

Sensitivity:	0.1 ohm on 200 Ω range
Overrange Capability:	Linear to 500 counts beyond maximum indication
Temperature Coefficient: (from 0°C to +50°C)	± (0.05% of reading +0.1 digit)/°C
Full Scale Step Response: (to rated accuracy)	1 second, except 10 seconds on the 20 MΩ range

3. AC VOLTAGE (Average-Sensing, RMS-Calibrated Sine Wave):

Range	Maximum Indication	Input Impedance	Overload Protected To
200 mV	199.9 mV	10MΩ and 100 pf	350 V rms
2 V	1.999 V	10MΩ and 100 pf	350 V rms
20 V	19.99 V	10MΩ and 100 pf	650 V rms
200 V	199.9 V	10MΩ and 100 pf	650 V rms
600 V*	600 V (Max. Input)	10MΩ and 100 pf	650 V rms

*40 Hz to 1 kHz

Accuracy: (from +15°C to +35°C)	± (0.5% of reading + 1 digit), 40 Hz to 1000 Hz ± (1.0% of reading + 1 digit), 1000 Hz to 10 kHz ± (2.0% of reading + 2 digits), 10 kHz to 20 kHz, except on 200 V range, which is ± (5% of reading + 2 digits)
Sensitivity:	100 microvolts on 200 mV range
Overrange Capability:	Linear to 500 counts beyond maximum indication (except on 600 V range, where any indication greater than 650 is an overload)

Full Scale Step Response: (to rated accuracy)	5 seconds
Temperature Coefficient: (from 0°C to +50°C)	± (0.05% of reading + 0.1 digit)/°C

4. DC CURRENT:

Range	Maximum Indication	Full Range Voltage Drop	Overload Protected To
20 μA	±19.99 μA	200 mV	±3 mA
200 μA	±199.9 μA	200 mV	±25 mA
2 mA	±1.999 mA	200 mV	*± 1/2 Amp
20 mA	±19.99 mA	200 mV	*±1/2 Amp
200 mA	±199.9 mA	200 mV	*±1/2 Amp
2 A	±1.999 A	200 mV	±3 Amps
10 A	±10.00 A (max. input)	100 mV	±10 Amps

*Fuse Protected

Accuracy: (from +15°C to +35°C)	± (0.5% of reading + 1 digit), except on 2A and 10 A ranges, which are ± (1.0% of reading + 1 digit)
Sensitivity:	10 nanoamps on 20 μA range
Overrange Capability:	Linear to 500 counts beyond maximum indication (except on 10 A range, where any indication greater than 1000 is an overload)
Full Scale Step Response: (to rated accuracy)	1 second
Temperature Coefficient: (from 0°C to +50°C)	± (0.03% of reading + 0.1 digit)/°C

5. AC CURRENT (40 Hz to 10 kHz):

Range	Maximum Indication	Full Scale Voltage Drop	Overload Protected To
200 μA	199.9 μA	200 mV	25 mA
2 mA	1.999 mA	200 mV	*1/2 Amp
20 mA	19.99 mA	200 mV	*1/2 Amp
200 mA	199.9 mA	200 mV	*1/2 Amp
2 A	1.999 A	200 mV	3 Amps
10 A	10.00 A (max. input)	100 mV	10 Amps

*Fuse Protected

Accuracy: (from + 15°C to +35°C)	± (1.0% of reading + 1 digit), except on 2A and 10 A ranges, which are ± (2.0% of reading + 2 digits)
Sensitivity:	100 nanoamps on 200 μA range
Overrange Capability:	Linear to 500 counts beyond maximum indication (except on 10 A range, where any indication greater than 10.00 is an overload)
Full Scale Step Response: (to rated accuracy)	5 seconds
Temperature Coefficient: (from 0°C to +50°C)	± (0.05% of reading + 0.1 digit)/°C

6. *RATED CIRCUIT-TO-GROUND VOLTAGE:

(Maximum Common Mode Voltage)	1000 volts (DC plus peak AC) maximum between any input terminal and power line (earth) ground

*The maximum voltage, with respect to ground, which may safely and continuously be applied to the circuit of an instrument.

7. DISPLAY:

Numerical Display:	3-1/2 digits. 7-segment, 0.43 inch light-emitting-diode (LED) type
Conversion Rate:	3 readings per second, nominal
Overrange Indication:	Automatic beyond 1999, with the "1" digit flashing
DC Polarity Selection:	Automatic, with "+" or "−" indication
Analog Display:	50-0-50 μA meter

8. ANALOG OUTPUT: The function of the ANALOG OUTPUT is to provide for analog monitoring by a chart recorder, or perhaps a companion analog instrument

Level:	1 volt DC with reading of 1000
Output resistance:	45 kΩ nominal
Accuracy:	The basic accuracy is that of the overall Instrument on the particular function and range being used, plus an additional possible error no greater than ±1% of maximum reading.

9. RESOLUTION: 1 part in 2000

10. POWER REQUIREMENT:

a. AC Operating or Battery Charging:	120 VAC, ±10%, 50 to 400 Hz (standard) 220 VAC, ±10%, 50 to 400 Hz (optional)
b. Battery Operation:	Four nickel-cadmium "C" size rechargeable cells, GE Cat. No. GCT 1.5 SB or Eveready CH 1.8 or equivalent; each cell is rated at 1.25 V, 1.5 ampere-hour min.

c. Operation time (continuous) with fully charged battery — 8 hours nominal

d. Recharge time (function switch in BATT CHRG ONLY position): — 16 hours nominal

e. Recharge time (while Instrument is in operation): — 30 hours nominal

11. TEMPERATURE RANGE:

Operating: 0°C to +50°C

Storage: −40°C to +60°C

12. REFERENCE CONDITIONS:

Temperature: +25°C ±1°C

Relative Humidity: 30 to 60%

Atmospheric Pressure: 575 to 800 mm Hg

13. WEIGHT:

(with battery): 4 pounds

Dimensions: 7.2" high, 5.4" wide, 2.75" deep (not including panel controls)

Table 1-2. Items Furnished With Instrument

Quantity	Description	Part No.
1	AC adapter/charger, 120 VAC	Cat. No. 12288
1	AC adapter/charger, 220V (optional)	Cat. No. 12289
1	Test Lead Set: One black and one red insulated lead having probe tips with provision for screw-on alligator clips (one red and one black supplied)	10-830115
1	Operator's Manual	5-118798

SECTION II
INSTALLATION

2.1 GENERAL

2.1.1 This section contains information and instructions for the installation and shipping of the 360-2. Included are unpacking and inspection procedures, warranty, shipping, power source requirements, installation and care.

2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for obvious signs of damage. Inspect the Instrument for possible damage incurred during shipment. If damage is noted, notify the carrier and supplier and do not attempt further use of the Instrument. If Instrument appears to be in good condition, read Operator's Manual in its entirety. Become familiar with the Instrument as instructed in the manual, then proceed to check the electrical performance as soon as possible. Also, check that all items are included with the Instrument (Table 1-2).

2.2.2 Save the shipping carton and packing materials for future storing or shipping of the Instrument.

2.3 WARRANTY

The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact your nearest Authorized Service Center for instructions. These centers are listed on the last pages of the manual. If you wish to contact the factory directly, give full details of the difficulty and include the instrument model number, serial number and date of purchase. Service data or shipping instructions will be promptly sent to you. If an estimate of charges for non-warranty or other service work is required, a maximum charge estimate will be quoted. This charge will not be exceeded without prior approval.

2.4 SHIPPING

2.4.1 Pack the Instrument carefully and ship it prepaid to the proper destination. Insure the Instrument.

2.5 POWER SOURCE REQUIREMENTS

CAUTION

Do not insert AC adapter/charger plug into the power source yet. Check that the designation on the adapter/charger agrees with the power source to be used.

2.5.1 The Simpson 360-2 is designed to be operated from either the supplied AC adapter/charger or self-contained nickel-cadmium cells (not furnished with the Instrument). Refer to Table 1-1.

2.5.2 AC Line or Battery Charging Operation

The Simpson 360-2 can be operated with the standard AC adapter/charger (12288) for 120 VAC, 50-400 Hz, or with optional AC adapter/charger (12289) for 220 VAC, 50-400 Hz operation.

2.5.3 Battery Operation

a. The Simpson 360-2 is supplied without batteries. The cells required (refer to Table 1-1, item 10), usually can be purchased from a local electronic parts distributor.

b. Battery operation is automatic whenever cells are installed, the AC adapter/charger is disconnected, and the function switch is set in the DC, OHMS or AC position.

c. For battery installation and battery test refer to paragraph 6.5.

2.6 INSTALLATION

The Instrument may be operated in any position. It can be inclined conveniently by positioning the Adjust-A-Vue Handle.

SECTION III
CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

All operating and adjustment controls, connectors, and indicators are described in Table 3-1. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT AND REAR PANEL DESCRIPTION

Table 3-1 lists all front and rear panel controls, connectors and indicators (see Figure 3-1 for identification).

Table 3-1. Front and Rear Panel Description

1. Function Selector Switch

Switch Position	Description
BATT CHRG ONLY	Connects the circuit to fully charge the battery in 16 hours nominal when the AC adapter/charger is connected to the recommended line voltage. The panel LED lights when the switch is in this position.
OFF	Disconnects all power from the internal circuits.
DC, OHMS	Connects the appropriate jacks to the DC voltage, DC current, or resistance measuring circuits, depending on the range switch position setting.
AC	Connects the appropriate jacks to the AC voltage or AC current measuring circuits, depending on the range switch position setting.

2. Range Selector Switch

Switch Position	Description
200mV, 2V, 20V, 200V and 1000VDC 600 VAC	Selects the desired range setting of DC volts (either polarity) or AC volts, depending on the function switch position setting. The input voltage is applied at the + and COMMON jacks.
200Ω Low Power, 20kΩ Low Power	Selects the circuits required for the measurement of resistance from "0" to 200Ω or

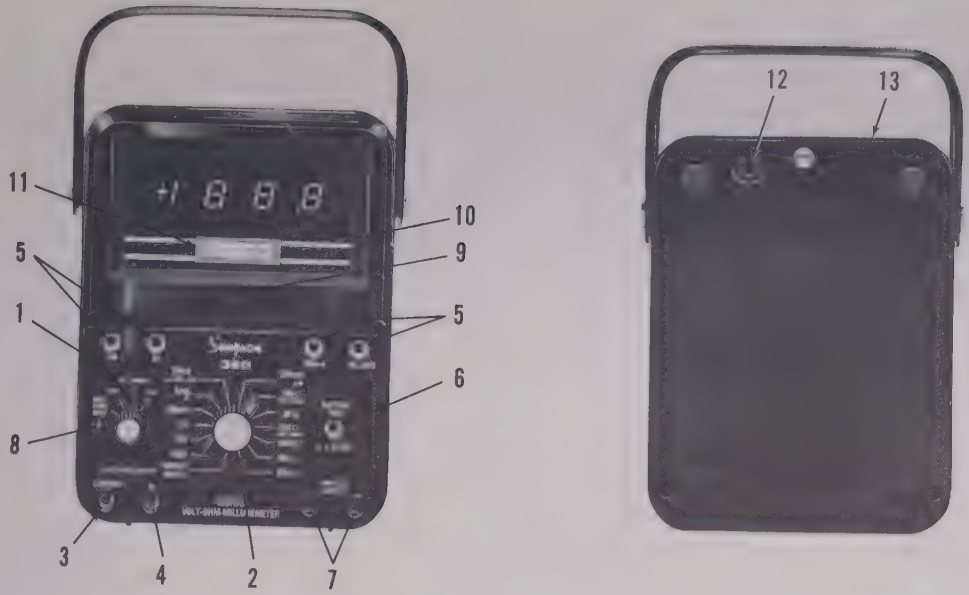

Figure 3-1. Front and Rear Panel Description

20kΩ, when the function switch is set to DC, OHMS position, and the input signal leads are connected to the + and COMMON jacks. The two LOW POWER resistance ranges have a maximum full-scale voltage of approximately 200 mV.

2kΩ, 200kΩ, 2MΩ, and 20MΩ — Selects the circuits required for the measurement of resistance from "0" to the corresponding range setting of kΩ or MΩ, when the function switch is set to DC, OHMS position, and the input signal leads are connected to the + and COMMON.

2mA, A — Selects the circuits required for the measurement of AC and DC current as follows:

Range	Function Switch Position	Input Connection
0 to ±2mA DC	DC, OHMS	+ and COMMON jacks
0 to 2mA AC	AC	
0 to ±2A DC	DC, OHMS	2A and COMMON jacks
0 to 2A AC	AC	

20mA, μADC, 10A — Selects the circuits required for the measurement of AC and DC current as follows:

Range	Function Switch Position	Input Connection
0 to ±20mA DC	DC, OHMS	+ and COMMON jacks
0 to 20mA AC	AC	
0 to ±20μA DC	DC, OHMS	20μA DC and COMMON jacks
0 to ±10A DC	DC, OHMS	10A and COMMON jacks
0 to 10A AC	AC	

200mA, μA — Selects the circuits required for the measurement of current as follows:

Range	Function Switch Position	Input Connection
0 to ±200mA DC	DC, OHMS	+ and COMMON jacks
0 to 200mA AC	AC	

0 to ±200μA DC	DC, OHMS	200μA and
0 to 200μA AC	AC	COMMON jacks

3. COMMON Jack

This jack is used to connect the "low" side of the circuit being measured to the internal circuit ground and is isolated from the AC power line ground.

4. + Jack

This terminal is used to connect the "high" side of the circuit being measured to all voltage, resistance, and some current measuring circuits through the range and function switches.

5. 20μA DC, 200μA, 2A and 10A Current Jacks

These terminals are used to connect the "high" side of the currents being measured and provide ranges of 0 to 20μA DC, 200μA AC or DC, 2A AC or DC, and 10A AC or DC depending on the position settings of the function and range switches. The "low" side is connected to the COMMON jack.

6. BATTERY TEST Jack

This jack connects the positive terminal of the battery (through an isolation resistor) when the internal battery is installed. For battery test, a test lead is connected between the + jack and the BATTERY TEST jack, with the function selector switch set in the DC, OHMS position and the range selector switch set in the 20V position. The numerical display must indicate greater than +4.70 volts for proper Instrument operation.

7. ANALOG OUTPUT, + and − Jacks

The signal from these jacks is a DC voltage which is directly proportional to the input signal, and whose value is 1 volt when the digital display indicates 1000 counts. These jacks accept test leads with insulated pin tip plugs, H. H. Smith type 491 or equivalent. See Table 1-1 for specifications.

8. Battery Charge Indicator

The light-emitting diode (next to the function switch) indicator illuminates when the function selector switch is set to the BATT CHRG ONLY position, with the AC adapter/charger connected. The indicator is used to indicate charging of the battery.

9. Zero Adjustment

The zero adjustment is a screwdriver adjusted potentiometer used to correct for a DC offset voltage at the input to the integrator/amplifier. It is adjusted to obtain a numerical indication of 000 when the input terminals are shorted together, with the function switch set on DC, OHMS and the range selector switch set on the 200mV position.

10. Numerical Display

The digital display uses LED's and includes a polarity (+, −) sign, a "1" digit, and three 7-segment type 0 to 9 digits and a decimal point, to indicate the polarity and the value of the signal being measured. The decimal point is properly positioned by the setting of the range selector switch. When an "overrange" condition exists, the "1" digit will flash.

11. Analog Display

This indicator has zero at its center. In conjunction with the position setting of the range switch, it displays in analog form the relative value of the input signal being measured. An indicator of this form can be very helpful when one is adjusting a circuit for a peak or a null.

12. AC Adapter/Charger Receptacle

This receptacle accepts either the 120 VAC (Cat. No. 12288) or 220 VAC (Cat. No. 12289) adapter/charger for AC operation or charging battery.

CAUTION

Be sure AC power source used matches power requirements of the AC adapter/charger.

13. Battery and Fuse Compartment Cover

Remove this cover (after disconnecting the AC adapter/charger) when installing the batteries, or when changing the OHMS and CURRENT fuses. One set of spare fuses is provided inside the compartment.

WARNING

Do not reconnect the AC adapter/charger to the Simpson 360-2 with the Battery and Fuse Compartment removed.

SECTION IV

OPERATION

4.1 GENERAL

WARNING

The Simpson 360-2 is designed to prevent accidental shock when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely prior to making any measurements. Failure to do so can result in a serious or fatal accident.

This section of the manual contains information required to operate the instrument in a safe and proper manner.

4.2 SAFETY PRECAUTIONS

4.2.1 The Simpson 360-2 is designed to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD definition on page v.

4.2.2 Do not work alone when making measurements where a shock hazard can exist. Notify another nearby person that you are or intend to make such measurements.

4.2.3 Remember, voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured and remove all power from the Simpson 360-2 before making connections or disconnections. The Instrument itself is well protected against electrical overload, as noted throughout paragraph 1.3. However, the above precautions are wise even in the laboratory, and especially in field usage of the Instrument where many strange or unknown safety hazards might prevail.

4.2.4 Locate all voltage sources and accessibility paths prior to making any measurement or connections.

4.2.5 For your own safety, inspect the test leads for cracks, breaks or crazes in the insulation prods and connectors before each use. If any defects exist, destroy and replace the defective item(s) immediately.

4.2.6 Do not make measurements in a circuit where corona is present. Corona can be identified by a pale-blue color emanating from sharp metal points in the circuit or a buzzing sound, or the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates presence of high voltage, and probably a malfunction of some kind.

4.2.7 Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or the Instrument.

4.2.8 For maximum safety, do not touch test leads, circuit, or Instrument while power is applied to the circuit being measured.

4.2.9 Use extreme caution when making measurements in an rf circuit where a dangerous combination of voltages could be present, such as in a modulated rf amplifier.

4.2.10 Do not use test leads which differ from those originally furnished with the Instrument.

4.2.11 Before the Instrument is used for AC operation, make sure that the power requirement of the AC adapter/charger matches with the power source to be used.

4.2.12 Do not float any input terminal more than 1000 volts (DC plus AC peak) with respect to the power line (earth) ground.

4.3 PRELIMINARY NOTES AND CHECKS

Prior to operation of the Instrument, review and perform (where applicable) the following notes and checks. These steps can be used also as a general functional check.

4.3.1 For AC line operation, insure that the power source used matches the requirements of the AC adapter/charger and insert the plug into a power outlet which conforms to the latest electrical code. The Instrument will operate with or without battery. When the Instrument is operating on the AC line with the internal battery installed, the battery is being "trickle" charged.

CAUTION

Do not operate the Instrument with cells in the completely discharged state, which is common for all new cells as acquired from the vendor. See paragraph 6.6.

4.3.2 Battery Operation

a. Disconnect the AC adapter/charger and set the function selector switch to the OFF position. Install four "C" size nickel-cadmium cells (not supplied with Instrument). Observe polarity as shown on label inside battery holder.

b. Set the range selector switch to the 20V position.

c. Set the function selector switch to the DC, OHMS position.

d. Connect a test lead between the + jack (lower left corner) and the BATTERY TEST jack. The reading must be greater than +4.7 volts for proper operation of the Instrument.

e. If the battery voltage is below +4.7 volts, or if the numerical display does not emit light, either the battery is improperly installed or recharging is required.

4.3.3 To recharge the battery

Refer to paragraph 6.6 for recharging procedure.

4.3.4 For a general functional check, use this procedure:

a. Connect the black test lead to the COMMON jack and the red test lead to the + jack. Short the test leads together.

b. Turn the function selector switch to the DC, OHMS position, and the range selector switch to the 200 KΩ position. The display will indicate 00.0.

c. Open the test leads. The numerical display will indicate 99.9 with the "1" digit flashing for an overrange condition.

d. Short the test leads together. The display reading will return to 00.0.

e. If difficulty is encountered in the above steps, see Section VI, paragraph 6.9 for Zero Adjust procedure.

4.3.5 On AC line operation, do not "float" any input terminal away from power line ground more than 1000 volts (DC plus AC peak).

4.4 DC VOLTAGE MEASUREMENT

4.4.1 **Review the safety precautions listed in paragraph 4.2.**

4.4.2 Connect input test leads to the + and COMMON terminals.

4.4.3 Turn the function selector switch to the DC, OHMS position.

4.4.4 Turn the range selector switch to the appropriate voltage range position as indicated in Table 4-1. If the voltage being measured is unknown, begin with the range selector switch set to the 1000 VDC position.

4.4.5 Turn off the power to the device or circuit under test, and discharge all capacitors.

CAUTION

Do not attempt to measure voltages on the 1000 VDC range which might be greater than 1100 volts DC.

4.4.6 Connect test leads to the circuit being measured.

4.4.7 Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity. The value of the voltage being measured will be indicated on the numerical display. The analog display will indicate the relative value and can be used for nulling or peaking applications.

4.4.8 Remove all power from the circuit being measured, discharge all capacitors, and disconnect test leads.

Table 4-1. DC Voltage Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Voltage	Remarks
0 to ±200mV	200 mV	DC, OHMS	+, COMMON jacks	±350V	Auto-Polarity
0 to ±2V	2V	DC, OHMS	+, COMMON jacks	±350V	
0 to ±20V	20V	DC, OHMS	+, COMMON jacks	±1100V	
0 to ±200V	200V	DC, OHMS	+, COMMON jacks	±1100V	
0 to ±1000V	1000V	DC, OHMS	+, COMMON jacks	±1100V	

4.5 AC VOLTAGE MEASUREMENT

4.5.1 **Review the safety precautions listed in paragraph 4.2.**

4.5.2 Connect input test leads to the + and COMMON terminals.

4.5.3 Turn the function selector switch to the AC position.

4.5.4 Turn the range selector switch to the appropriate voltage range position, as indicated in Table 4-2. If the voltage being measured is unknown, begin with the range selector switch set to the 600 VAC position.

CAUTION

Do not attempt to measure voltages on the 600V range which might be greater than 650 volts.

4.5.5 Remove all power from the circuit being measured and discharge all capacitors.

Table 4-2. AC Voltage Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Voltage	Frequency Range
0 to 200mV	200mV	AC	+, COMMON jacks	350V rms	40 Hz to 20 kHz
0 to 2V	2V	AC	+, COMMON jacks	350V rms	
0 to 20V	20V	AC	+, COMMON jacks	650V rms	
0 to 200V	200V	AC	+, COMMON jacks	650V rms	
0 to 600V	600V	AC	+, COMMON jacks	650V rms	40 Hz to 1 kHz

4.5.6 Connect test leads to the circuit being measured.

4.5.7 Apply power to the circuit being measured. The value of the voltage being measured will be indicated on the numerical display. The analog display can be used for nulling or peaking applications.

4.5.8 Remove all power from the circuit being measured, discharge all capacitors, and disconnect test leads.

4.6 RESISTANCE MEASUREMENT

4.6.1 Review and comply with the Preliminary Notes and Checks, paragraph 4.3.

4.6.2 Connect input test leads to the + and COMMON terminals.

4.6.3 Turn the function selector switch to the DC, OHMS position.

4.6.4 Turn the range selector switch to the appropriate resistance range position as indicated in Table 4-3.

4.6.5 If the resistance being measured is connected into a circuit, **be certain that all power is removed from the circuit and all capacitors are discharged.** Check for alternate resistance paths other than the resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

4.6.6 Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the presumed and actual value.

NOTE: If the resistance being measured is polarity or voltage sensitive (for example, semiconductors), careful considerations must be given when making connections and selecting the resistance range (refer to Table 4-3).

Table 4-3. Resistance Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max.Full Scale Voltage	Remarks
0 to 200Ω	200Ω Low Power	DC, OHMS	+, COMMON jacks	200mV	Low Power
0 to 2kΩ	2kΩ	DC, OHMS	+, COMMON jacks	2V	
0 to 20kΩ	20kΩ Low Power	DC, OHMS	+, COMMON jacks	200mV	Low Power
0 to 200kΩ	200kΩ	DC, OHMS	+, COMMON jacks	2V	
0 to 2MΩ	2MΩ	DC, OHMS	+, COMMON jacks	2V	
0 to 20MΩ	20MΩ	DC, OHMS	+, COMMON jacks	2V	

4.6.7 Allow time for the display to stabilize. This is especially important when measuring a high value resistance shunted by a large value of capacitance.

4.6.8 Disconnect test leads.

4.6.9 If no additional immediate resistance measurements are required, rotate the range selector switch to the 1000 VDC 600 VAC position and the function selector switch to the OFF position. These settings avoid the possibility of accidentally applying voltage to the resistance circuits, and causing the internal protective fuse to open.

4.7 DC CURRENT MEASUREMENT

4.7.1 Review the safety precautions listed in paragraph 4-2.

4.7.2 Turn the function selector switch to the DC, OHMS position.

4.7.3 Turn the range selector switch to the appropriate current range position as indicated in Table 4-4. If the current being measured is unknown (but less than 10 A), begin with the range selector switch set to the 20mA, μADC, 10 A position and connect the red test lead to the 10 A jack and the black test lead to the COMMON jack.

4.7.4 Remove all power to the circuit being measured and discharge all capacitors.

4.7.5 Connect the test leads according to Table 4-4.

4.7.6 Open the circuit in which the current is to be measured and connect the test leads in series. Insure that the Simpson 360-2 is not connected across a voltage source which can exceed the range setting of the Instrument.

4.7.7 Apply power to the circuit being measured.

4.7.8 The value of the current being measured is indicated on the numerical display. The analog display can be used for nulling or peaking applications.

Table 4-4. DC Current Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Current	Remarks
0 to ±20μA	20mA μADC, 10A	DC, OHMS	20μADC, COMMON jacks	±3 mA	
0 to ±200μA	200mA μA	DC, OHMS	200μA, COMMON jacks	±25 mA	
0 to ±2mA	2mA A	DC, OHMS	+, COMMON jacks	±1/2 Amp *	Auto-Polarity
0 to ±20mA	20mA μADC, 10A	DC, OHMS	+, COMMON jacks	±1/2 Amp *	
0 to ±200mA	200mA μA	DC, OHMS	+, COMMON jacks	±1/2 Amp *	
0 to ±2A	2mA A	DC, OHMS	2A,COMMON jacks	±3 Amp	
0 to ±10A	20mA μADC, 10A	DC, OHMS	10A,COMMON jacks	±10 Amp	

*Fuse Protected

4.7.9 Remove all power from the circuit being measured and discharge all capacitors.

4.7.10 Disconnect the test leads and reconnect the circuit which was originally opened.

4.7.11 If no additional, immediate current measurements are required, rotate the range selector switch to the 1000 VDC 600 VAC position and the function selector switch to the OFF position. These settings avoid the possibility of accidentally applying voltage to the current circuits, which can cause damage to the Instrument.

4.8 AC CURRENT MEASUREMENT

4.8.1 Review the safety precautions listed in paragraph 4.2.

4.8.2 Turn the function selector switch to the AC position.

4.8.3 Turn the range selector switch to the appropriate current range position as indicated in Table 4-5. If the current being measured is unknown (but less than 10A), begin with the range selector switch set to the 20mA, μADC, 10A position and connect the red test lead to the 10 A jack. Connect the black test lead to the COMMON jack.

4.8.4 Remove all power from the circuit being measured and discharge all capacitors.

4.8.5 Open the circuit in which the current is to be measured and connect the test leads in series. Insure that the Simpson 360-2 is not connected across a voltage which can exceed the range setting of the Instrument.

4.8.6 Connect the test leads according to Table 4-5.

Table 4-5. AC Current Ranges and Connections

Range	Range Switch Position	Function Switch Position	Input Connections	Max. Current	Frequency Range
0 to 200μA	200mA μA	AC	200 μA, COMMON jacks	25 mA	40 Hz to 10 kHz
0 to 2mA	2mA A	AC	+, COMMON jacks	1/2 Amp *	
0 to 20mA	20mA μADC, 10A	AC	+, COMMON jacks	1/2 Amp *	
0 to 200mA	200mA μA	AC	+, COMMON jacks	1/2 Amp *	
0 to 2A	2mA A	AC	2A,COMMON jacks	3 Amps	
0 to 10A	20mA μADC, 10A	AC	10A,COMMON jacks	10 Amps	

*Fuse Protected

4.8.7 Apply power to the circuit being measured.

4.8.8 The value of the current being measured is indicated on the numerical display. The analog display can be used for nulling or peaking applications.

4.8.9 Remove all power from the circuit being measured and discharge all capacitors.

4.8.10 Disconnect the test leads and reconnect the circuit which was originally opened.

4.8.11 If no additional, immediate current measurements are required, rotate the range selector switch to the 1000 VDC 600 VAC position and the function selector switch to the OFF position. These settings avoid the possibility of accidentally applying voltage to the current circuits, which can cause damage to the Instrument.

4.9 OPERATION WITH RECORDERS

4.9.1 The ANALOG OUTPUT terminals of the Simpson 360-2 may be connected to the input terminals of a graphic recorder. Operational information of the particular recorder is covered in the Operator's Manual for the recorder.

4.9.2 The ANALOG OUTPUT terminals provide 1 volt DC (open circuit), corresponding to a digital indication of 1000, with a nominal resistance of 45 k ohms. This output is sufficient for use with general purpose, non-potentiometric recorders. Hence, it offers capabilities not otherwise possible in a low-cost package.

4.9.3 The Simpson 360-2 provides isolation for the recorder (10 MΩ on DC volts) combined with the numerous functions of AC/DC volts, resistance and AC/DC current.

4.9.4 The Simpson Models 603 (Cat. No. 20201), 604 (Cat. No. 12610), and 2750 (Cat. No. 22002) are excellent examples of low cost recorders which can be used with the Simpson 360-2.

4.9.5 The Models 603 and 2750 specified in paragraph 4.9.4 are basically 0 to 50 μA DC instruments and will require a series

multiplier resistance to convert the recorder to a 2 volt or 2.5 volt instrument. Since the standard chart paper markings for the recorders are 50 divisions, a 2.5 volt range is recommended.

NOTE: On other than the 1000 VDC 600 VAC ranges, the Simpson 360-2 has measurement capability beyond an indication of 1999. It is linear to an equivalent indication of 2500.

4.9.6 The series multiplier resistance required will be approximately 5 kΩ, minus the recorder resistance (1000 to 2000 Ω, typically). To allow for the accuracy of the recorder, the series multiplier should be made of a variable resistor of 5 kΩ. The following procedure is used for setting up either recorder.

a. Connect the Simpson 360-2 to the Model 2750 or Model 603 recorder, and a 0 to 2 VDC voltage source as shown in Figure 4-1.

b. Adjust the output of the 0 to 2 VDC voltage source for an indication of 1.950 on the 360-2.

c. Adjust the 5 kΩ variable resistance for an indication on the recorder chart paper of 39 divisions.

d. The recorder is now calibrated to the Simpson 360-2. Each division marking on the recorder chart paper equals 50 counts on the Simpson 360-2 digital display. Therefore, 39 divisions equals 1950 counts. The decimal point location and units being measured are determined by the Simpson 360-2 function and range selection.

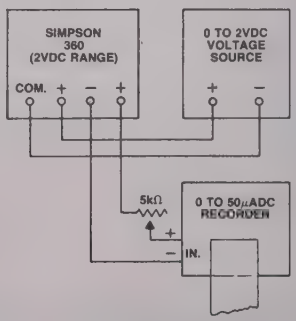

Figure 4-1. Connections For Use of The Model 603 or 2750 Recorder With The Simpson 360-2

SECTION V

THEORY OF OPERATION

5.1 OVERALL SYSTEM

The basic system diagram for the Simpson 360-2 is shown in Figure 5.1.

5.1.1 Signal Conditioning Section

The parameter being measured is connected to the appropriate input terminals. The corresponding Signal Conditioning circuits convert this parameter into a proportional DC voltage. The conversion is accomplished by the Attenuator, Current Shunts, Resistance Converter, AC-to-DC Converter, and associated switching.

5.1.2 Analog-To-Digital Converter Section

The Analog-To-Digital (A/D) Converter section changes the DC output voltage from the Signal Conditioning section to digital information. The A/D Converter also provides a proportional analog signal for both the Analog Display and Analog Output.

5.1.3 Display Section

Through the Segment and Anode Drivers, the digital information from the A/D converter are indicated on the 7-segment Numerical Display. The proportional analog signal is indicated by the Analog Display.

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements

The basic DC voltage measurement circuit is shown in Figure 5-2(A). The DC voltage being measured is connected to the + and COMMON jacks, attenuated according to the range selected and converted into digital information by the A/D converter.

5.2.2 The A/D Converter circuit provides two basic full range sensitivities: 200 mV and 2V. This feature simplifies the attenuator design. No attenuation is required on the 200mV and 2V ranges. The same attenuator ratio is used on the 20V and 200V ranges. A separate attenuator tap is provided for the 1000 volt range.

Figure 5-1. Basic System Diagram

5.2.3 AC Voltage Measurements

The basic AC voltage measurement circuit is shown in Figure 5-2 (b).

5.2.4 The AC voltage being measured is connected to the + and COMMON jacks, attenuated according to the range selected, and applied to an Input Amplifier. The output of the amplifier is converted into DC by an AC to DC Converter, and the resulting DC voltage is measured by the A/D Converter.

5.2.5 The attenuator is not used on the 200mV and 2V ranges. On the higher ranges, the attenuator is frequency-compensated to provide good accuracy over a wide frequency range.

5.2.6 The Input Amplifier achieves a high input impedance and presents a low output impedance to the converter.

5.2.7 The AC to DC Converter uses a half-wave operational amplifier/rectifier circuit which provides two basic full range sensitivities: 200mV and 2V. It is average-responding, but its calibration (gain) is based on the rms value of a sine wave.

5.2.8 The output of the Operational Amplifier has two rectifying diodes and two feedback resistors, R1 and R2. These components drive a summing resistor R3. The junction of the summing resistor and feedback resistors is connected to the amplifier input to provide negative feedback. With a sinewave input signal, the positive half cycles of the output waveform go through one diode, and the negative half cycles through the other diode. The positive half cycle is filtered and the resulting DC voltage is measured by the A/D Converter.

5.2.9 The indications of the numerical display are calibrated to the rms sine wave value being measured.

5.2.10 AC Current Measurements

The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (refer to 5.2.11), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

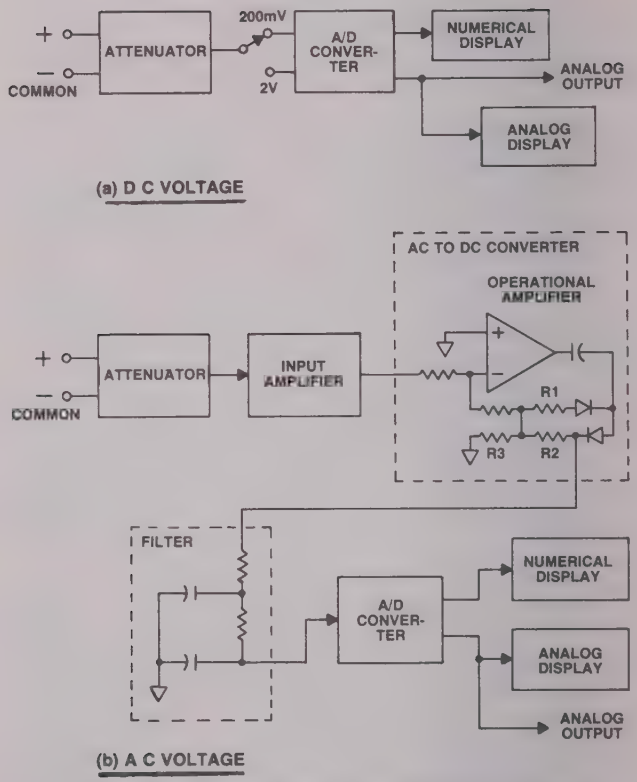

Figure 5-2. Basic Voltage Measurement Circuits

5.2.11 DC Current Measurements

The basic DC current measurement circuit is shown in Figure 5-3 (a).

5.2.12 The current being measured is connected in series with the COMMON and appropriate jack and an internal precision shunt resistance. The value of the shunt resistance depends on the current range used and is selected so that the voltage developed across it is proportional and numerically equal to the current

through it. The A/D Converter measures this voltage, and the value indicated on the numerical display is equal to the current being measured.

5.2.13 The full range sensitivity of the digital voltmeter circuit measurements is 200mV. Therefore, the internal resistance for each current range equals 200mV divided by the full range current. For example, if the full range current is 200 μA, then the internal resistance would be 1000 ohms.

5.2.14 Resistance Measurements

The basic resistance circuit is shown in Figure 5-3 (b).

5.2.15 The resistance being measured, Rx, is connected to the + and COMMON jacks and a constant current is applied through it by the Instrument. The resulting voltage is proportional to the value of Rx. The value of the current is determined by the resistance of the range selected.

5.2.16 The current through Rx, is controlled by an Operational Amplifier whose inputs "follow" Ex and the output is always Ex + 1 volt. The 1 volt reference for the amplifier is developed by the current from a Constant Current Source through a 6.5 kΩ feedback resistor.

5.2.17 The Ex + 1 volt output of the amplifier maintains a constant current through Rx, regardless of the value of Rx. The magnitude of the current is determined by the resistance (precision resistors selected by the ohms range switch) in series with Rx.

5.2.18 The A/D Converter measures the voltage developed across Rx, and the value indicated on the numerical display is equal to the resistance of Rx.

5.2.19 When the Instrument is set for LOW POWER resistance measurements (either the 200Ω and 20 kΩ range), the full-scale voltage across Rx is set to 200 mV. This feature limits the power applied to the resistance being measured to less than 200 μW.

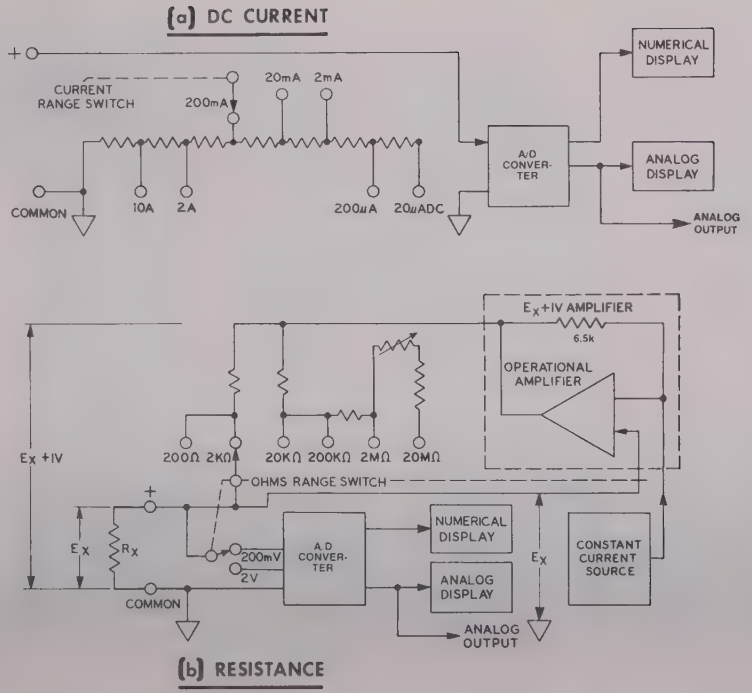

Figure 5-3. Basic DC Current and Resistance Measurement Circuits

5.3 A/D CONVERTER

5.3.1 The basic block diagram of the A/D Converter is shown in Figure 5-4. The circuit utilizes the "Up-Down" integration technique for the analog-to-digital conversion. This technique is based on the conversion of a DC voltage into a proportional time period. The converter initially accumulated a charge proportional to the input signal on an integrator capacitor for a fixed period of time. In the second integration period, the capacitor discharges back to the "zero" voltage starting point, when the input signal is remove a reference voltage opposite in polarity is placed at the input of converter. The ratio of the time required to remove the integrator charge to the initial fixed time period is proportional to the amplitude of the input DC voltage.

5.3.2 The "Up-Down" A/D Converter requires two periods of integration for each measurement. The input signal (E_{in}) is integrated on the "up" slope during the first period; the reference voltage is integrated on the "down" slope of the second period. The first period starts with a pulse initiated by the Sample & Reset Oscillator which generates three pulses per second as shown in (1) of the Basic Timing Diagram (Figure 5-5).

5.3.3 The pulse resets the Decade Counters to "zero" and the trailing edge of the pulse initiates the first period T_1. During T_1, the DC voltage E_{in} is sampled, and the Integrator generates a ramp whose slope is proportional to the value of the input signal. Also during T_1, the Master Oscillator (2) produces pulses which are counted by the Decade Counters until a total of 1,000 counts is accumulated. At this moment, period T_1 ends and T_2 begins.

5.3.4 During T_2, the input signal is removed, and a reference voltage of the opposite polarity is connected to the Integrator input. The Integrator at this time produces a ramp toward the starting point with a fixed slope as shown in (6) of the timing diagram. When the Integrator output has reached the "zero" voltage starting point, the Zero Detector changes state. At this point the reference voltage is removed and the Control Logic inhibits the Master Oscillator.

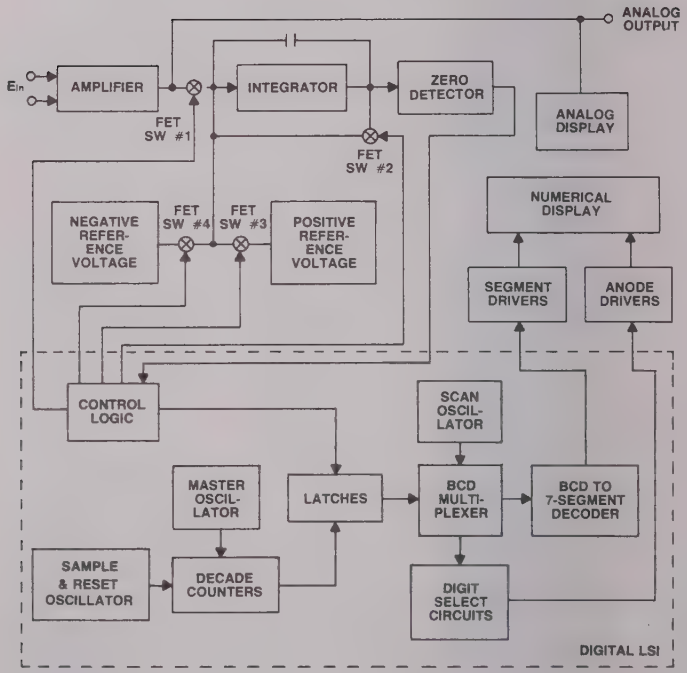

Figure 5-4. Block Diagram of A/D Converter

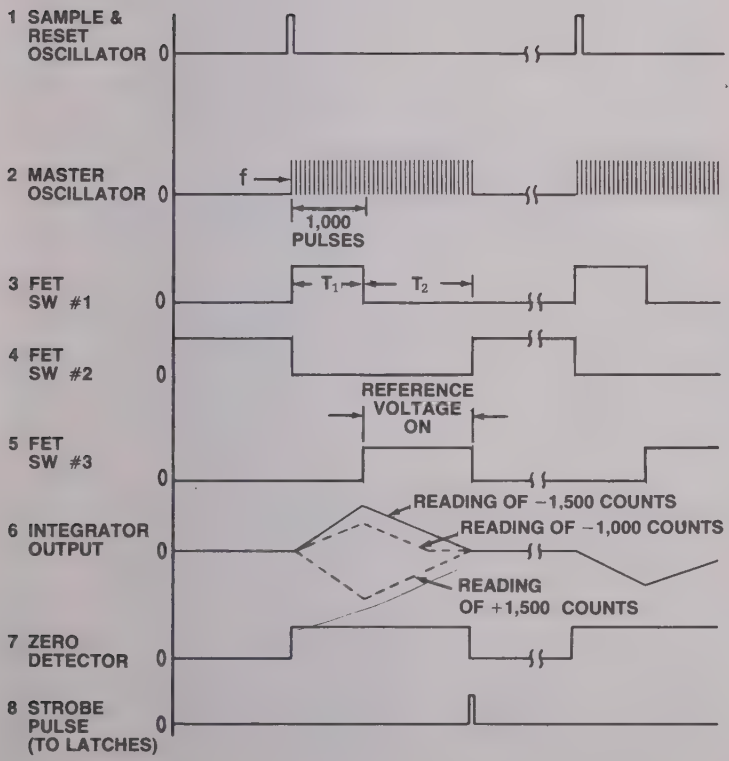

Figure 5-5. Simpson 360-2, Basic Timing Diagram

5.3.5 The count stored in the Decade Counters is in turn transferred to the Latches via a strobe pulse (8) generated by the Control Logic. The BCD information is then multiplexed, decoded into 7-Segment information, and numerically displayed through the Segment and Anode Drivers.

5.3.6 The other requirements of the A/D Converter such as overrange and polarity indications are accomplished by the Control Logic and Counter Circuits.

5.4 AC ADAPTER/CHARGER AND POWER SUPPLY

5.4.1 The basic block diagram for the 360-2 AC Adapter/Charger and power supply circuits is shown in Figure 5-6.

5.4.2 When the Simpson 360-2 is operated from an AC power line, the incoming AC power is applied to transformer T_1 of the AC Adapter/Charger. T_1 steps down the voltage as required by the rectifier circuit.

5.4.3 The rectifier circuit is a full-wave center-tap circuit which converts the incoming AC into an unregulated DC voltage. This voltage is applied to a Series Type Regulator Circuit to produce +5 volts DC. The network comprising R1 and R2 provides the proper charging current for the battery.

5.4.4 The DC-to-DC Converter changes the regulated 5 volt DC (or battery voltage) into an AC signal. This AC signal is then stepped up and rectified to provide regulated outputs of ±10 Volts DC.

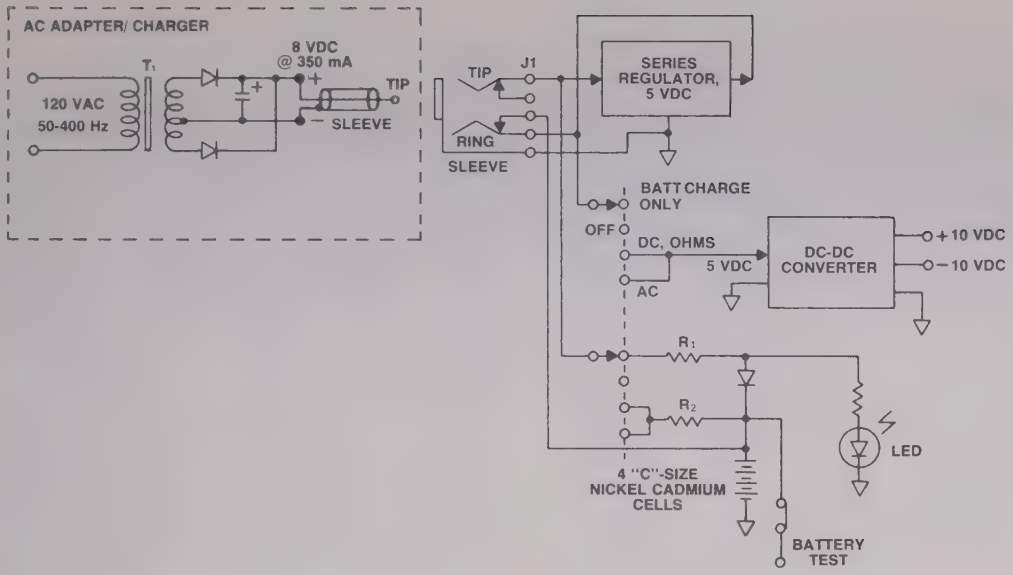

Figure 5-6. Simpson 360-2 Power Supply, Schematic

SECTION VI

MAINTENANCE

6.1 GENERAL

WARNING

The Instrument can measure voltages which constitute a SHOCK HAZARD. Review what constitutes a SHOCK HAZARD as explained on page v. Internal adjustments or repairs must be performed only by qualified personnel who understand and can recognize what constitutes a SHOCK HAZARD, preferably a Simpson Authorized Service Center.

The Simpson 360-2 is carefully designed and constructed with high quality components. By providing reasonable care, and following the instructions in this manual, the user can expect a long, useful service life from his Instrument.

6.2 BATTERY AND FUSE COMPARTMENT COVER REMOVAL

WARNING

Remove all power and input connections to the Instrument before removing the back cover. Do not operate the Instrument with the back cover removed.

To install or replace battery and fuses, remove the back cover as follows:

a. Turn the function selector switch to the OFF position.

b. Disconnect the AC adapter charger from the power source and all connections from the Instrument.

c. Loosen the single captivated screw and remove the cover.

d. Reverse the above procedure when replacing the cover.

6.3 BATTERY INSTALLATION

6.3.1 Recommended cells: Four "C" size, 1.25V, 1.5 ampere-hour nickel-cadmium rechargeable (GE Cat. No. GCT 1.5 SB or Eveready CH 1.8).

CAUTION

Standard carbon zinc or alkaline "C" size cells can be used in an emergency. However, the adapter/charger must be removed to prevent charging these cells in the Instrument. These cells do not have provision for pressure relief and can burst when charged. Immediately remove the cells when the emergency is over or when they are discharged, and replace with nickel-cadmium cells at your earliest convenience.

6.3.2 Install the cells as follows:

a. Remove back cover (refer to 6.4). Install the cells in pairs, according to the orientation designated on the battery holder label. Position the two inner cells over the pull-out strap in the battery compartment as shown in Figure 6-2. Push downward firmly at the points A and B as shown in illustration.

NOTE: To remove the cells, pull strap upward.

b. Check that the battery contacts are clean and making good connection.

c. Replace the cover.

d. For battery recharging, refer to paragraph 6.6.

e. Test the battery according to paragraph 4.3.2.

6.4 BATTERY RECHARGING

a. With the function selector switch set to the OFF position, insert the AC Adapter/Charger into a power outlet which conforms to the designated power requirements and to the latest electrical code.

b. Turn the function selector switch to BATT CHRG ONLY position. The LED pilot indicator will light. The battery is being charged at full rate.

NOTE: If the battery test indicates a voltage less than 4.7 volts, leave the Instrument in BATT CHRG ONLY position for at least 15 minutes before operating.

c. Time for complete recharge of the battery is 16 hours nominal with the function switch set in the BATT CHRG ONLY position. Time for complete recharge of battery is nominally 30 hours while the selector switch is in either the DC, OHMS or AC position.

6.5 BATTERY CARE

6.5.1 Avoid allowing the cells to get completely discharged. Check the battery voltage periodically using the BATTERY TEST jack (refer to paragraph 4.3.2). Charge the battery whenever its voltage is close to, or below, 4.7 volts.

6.5.2 Do not operate the Instrument with discharged cells. Make sure to recharge all newly purchased batteries (refer to paragraph 6.6) for at least 15 minutes before operating the Instrument.

6.5.3 Observe polarity when installing the batteries.

6.5.4 Whenever the AC Adapter/Charger is not connected, and the Instrument is not in use, remember to turn the function switch to the OFF position.

6.5.5 With nickel-cadmium cells installed in the 360-2, avoid storing in an area where the temperature exceeds +60°C.

6.6 FUSE REPLACEMENT

The current fuse and resistance fuse are mounted inside the battery and fuse compartment as shown in Figure 6-1. A spare for each fuse is provided. Use the following procedure to replace a fuse.

WARNING

Remove all power and input connections to the Instrument before removing the back cover.

6.6.1 Remove the back cover as described in 6.4.

6.6.2 Carefully lift the defective fuse from the holder and replace with appropriate fuse according to the following:

F1, current fuse: 1/2A, 250V, Type 8AG, Fast-Blo

F2, resistance fuse: 1/16 A, 250V, Type 8AG, Fast-Blo

6.6.3 Replace the back cover.

6.7 ZERO ADJUSTMENT

6.7.1 The Simpson 360-2 has been calibrated at the factory using precision instruments. The higher order of accuracy and stability of the Instrument eliminate the need for frequent recalibration. However, should "zero adjustment" be required after a long period of time or extreme temperature conditions, use the following procedure:

a. Connect test leads to the + and COMMON terminals.

b. Turn the function selector switch to the DC, OHMS position.

c. Turn the range selector switch to the 200mV position.

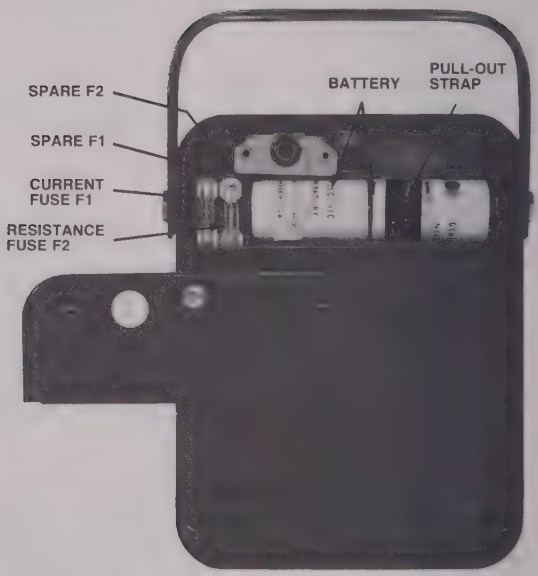

Figure 6-1. Simpson 360-2 Fuse Location

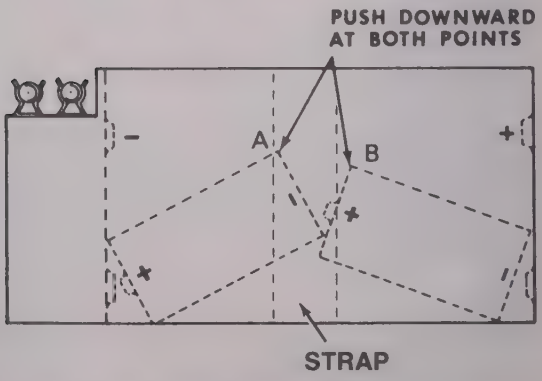

Figure 6-2. Battery Positioning For Installation

d. Short the test leads together.

e. Allow the Instrument to warm up for 15 minutes.

f. Using an insulated screwdriver, adjust the potentiometer through the hole located directly below the analog display for a numerical display of 00.0.

6.8 CARE

6.8.1 Daily Care

a. Immediately clean all spilled materials from the Instrument and wipe dry.

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source or when it is connected to the AC power line.

b. Avoid allowing the battery to fully discharge. Check the battery voltage according to paragraph 4.3.2.

c. Whenever possible, avoid prolonged exposure or usage in areas which are subject to: temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interferences.

6.8.2 Monthly Care

Verify Instrument calibration by performing operational checks using known value sources. If the need for calibration is indicated, contact your nearest Simpson Authorized Service Center.

6.8.3 Annual Care

It is recommended that the Instrument be returned annually to a Simpson Authorized Service Center or the factory for a complete overall check, adjustment, and calibration.

6.8.4 Storage

When the Instrument is not in use, store it in a location free from temperature extremes, dust and corrosive fumes, and mechanical vibration or shock.

6.9 TROUBLESHOOTING

6.9.1 If the Instrument does not yield satisfactory results, perform the following procedure before attempting maintenance on the Instrument:

a. Review and comply with the Preliminary Notes and Checks, listed in paragraph 4.3.

b. Check that all controls are positioned correctly for the parameter and range of value being measured and that the measurement is within the rating of the Instrument.

c. If the Instrument is battery operated, insure that the cells are charged and are installed properly (refer to 6.5).

d. If the Instrument is AC line operated, insure that power source is within the AC adapter/charger specifications, and free from excessive fluctuations and transients.

e. Insure that the environment in which the Instrument is being used is within the Instrument specifications.

f. Inspect the device being measured and the measurement test set-up to insure that proper shielding and grounding techniques have been used. If power line effects are suspected, operate the Instrument on battery. Also consider whether the Instrument is significantly affecting the circuit being measured.

6.9.2 If the steps taken in paragraph 6.11.1 do not yield satisfactory results, refer to the troubleshooting chart (Table 6-1). All other repairs and adjustments must be directed to a Simpson Authorized Service Center.

Table 6-1. Troubleshooting Chart

Symptom	Probable Causes	Cure
1. No indication on numerical and analog display when Instrument is battery operated. AC operation is OK.	Cells — Discharged, defective, not installed properly, making poor contact, or missing.	Check battery voltage. Refer to para. 4.3.2. If OK contact nearest Simpson Authorized Service Center.
2. LOW intensity on numerical display in battery operation.	Cells not fully charged.	Check battery voltage. Refer to para. 4.3.2. If battery checks low, remove cover and check that the cells are installed correctly and making good contact. Refer to 6.5. If they are, replace cover and charge battery overnight. Refer to para. 6.6.
3. No indication on the numerical and analog displays when Instrument is AC line operated (no cells installed).	a. Low or no voltage at power source receptacle. b. AC adapter/charger disdisconnected. c. Defective AC adapter/charger.	a. Restore correct voltage at power receptacle. b. Connect AC adapter/charger. c. Replace AC adapter/charger.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
4. Batteries do not respond to charge. Instrument operation OK when connected to AC power.	Cells defective, not installed properly, making poor contact, or missing.	Remove cover and check that cells are installed correctly and making good contact. Refer to 6.5. If they are, check the voltages of the individual cells. Replace those which check significantly lower than nominal (1.25 volts).
5. Operation normal on all functions and ranges except on 200Ω and 2kΩ resistance ranges.	Resistance fuse F2 open.	Replace fuse F2. Refer to 6.8.
6. Operation normal on all functions and ranges except AC and DC current.	Current fuse F1 open.	Replace fuse F1. Refer to 6.8.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
7. Indications fluctuate and/or drift, even though indication is OK at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance input.	Fluctuations and/or drift are being generated by the device being measured or the measurement test set up.	Use proper shielding, ground-techniques, and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling. Operate Instrument on battery for complete isolation from the power line. NOTE: If the drift and/or fluctuation is coming from the device being measured, no cure is required, the measurement is valid, and the device must be corrected.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
8. Indication is OK on battery. However, on AC operation, the reading fluctuates and/or drifts at 000, with the input shorted, and/or at 1000 counts using a stable and low impedance input.	AC power source is low or fluctuating (including transients).	Correct the power source or use Instrument on battery.
9. Same as 8 above, except indication OK on AC but not on battery operation.	a. Battery voltage low. b. One or more cells defective, not installed correctly.	a. Check battery condition. Refer to para. 4.3.2. If not OK charge battery, refer to para. 6.6. b. Remove back cover and check that cells are installed correctly and making good contact. If OK, replace all cells temporarily with conventional carbon zinc "C" size cells for checking purposes only. If problem still exists, contact nearest Simpson Authorized Service Center.

Table 6-1. Troubleshooting Chart (continued)

Symptom	Probable Causes	Cure
10. Slow response. Operation OK when using a low impedance input.	Parameter being measured has a high source impedance.	None required.
11. Accuracy not within specifications when checked with a stable, higher accuracy (at least 5 times better) low impedance (voltage measurements) source.	a. Instrument is out of calibration. b. Instrument not zeroed properly.	a. Contact nearest Simpson Authorized Service Center. b. Perform ZERO adjustment. Refer to para. 6.9.
12. Accuracy of Instrument is within specifications but measurements appear in error.	a. Instrument affects circuit being measured. b. Common and/or normal mode specification is being exceeded.	a. Study circuit being measured vs. Instrument specifications. Correct indications accordingly. b. Refer to cure in item 7 above.

SECTION VII

ORDERING INFORMATION, SCHEMATIC DIAGRAM AND AUTHORIZED SERVICE CENTERS

Table 7-1. Replacement Parts List

Reference Symbol	Description	Part No.
	Alligator clip (without insulator)	1-115963
	Cover, assembly, case, battery	10-560241
	Insulator, Alligator Clip, Red	5-112479
	Insulator, Alligator Clip, Black	5-111169
	Knob, bar	5-116237
	Knob, pointer	5-116216
	Spring, coil, grounding	5-228811
C103.111 112.113. 114	Capacitor, 15μf −10 +75%, 16V	5-115534
C104	Capacitor, 470pf, ±5%, 250V	5-118406
C105	Capacitor, 330pf, ±5%, 250V	5-118749
C106	Capacitor, Trimmer 5.5 −60pf, 100V	5-116235
C107	Capacitor, 2.2pf, ±5%, 1kV	5-114987
C108	Capacitor, 56pf, ±20%, 1kV	5-110934
C109	Capacitor, Elec. 220μf −10 +50%, 10V	5-117738
C110	Capacitor, .022μf, ±20%, 100V	5-116188
C115	Capacitor, .15μf, ±5%, 100V	5-117279
C116,123	Capacitor, .001μf, GMV, 1kV	5-111119
C117	Capacitor, .1μf −20 +80%, 30V	5-113883
C118	Capacitor, 100pf, ±10%, 1kV	5-113217
C119	Capacitor, .22μf, ±10%, 100V	5-118750

C120	Capacitor, 330pf, ±20%, 500V	5-112690
C121	Capacitor, .047μf, ±10%, 250V	5-112538
C122	Capacitor, 100pf, ±5%, 500V	5-118748
C124	Capacitor, .1μf, ±10%, 630V	5-116189
C201,202, 204,205, 210,212, 214	Capacitor, 15μf −20 +50%, 16V	5-115534
C203	Capacitor, .022μf, ±20%, 100V	5-116188
C206	Capacitor, 6pf, ±5%, 300V	5-115539
C207	Capacitor, 62pf, ±5%, 300V	5-116187
C208	Capacitor, 2.2μf, ±10%, 16V	5-115533
C209	Capacitor, 1.0μf, ±10%, 16V	5-115531
C211,213	Capacitor, .1μf −20 +80%, 30V	5-113883
D101,103, 104,105, 106	Diode, Silicon, 100PIV, 10D1	5-114005
D107,108, 109,110, 111, 112, 113,114, 115	Diode, Silicon, 75PIV, IN914	5-112004
D116	Diode, Ref. Zener, 6.4V, IN4576	5-116201
D117	Diode, Zener, 6.8V, IN754A	5-116323
D201,202	Diode, Silicon, DE-113	5-118868
D203,204	Diode, Silicon, 75PIV, IN914 Selected	5-117379
D205,206	Diode, Zener, 9.5V, DZ720215A	5-116203
D301	Diode, Silicon, 75PIV, IN914	5-112004
DS301 thru 303	Readout, LED, 7-Segment	5-118779
DS304	Readout, LED, ±1	5-118780
F1	Fuse, 1/2A, 250V, 8AG, Fast-Blo	5-116359
F2	Fuse, 1/16A, 250V, 8AG, Fast-Blo	5-118768

IC101	I.C. Operational Amp. LM312H (selected)	5-118746
IC102,108	I.C. Operational Amp. LM308N	5-116598
IC103	I.C. Operational Amp. LM301AN	5-118745
IC104	I.C. Dual Operational Amp. LM1458N	5-117432
IC105	I.C. QUAD Comparator LM2901N	5-118747
IC106	I.C. A/D Digital Custom LSI	5-118744
IC107	I.C. Operational Amp. LM741CN	5-115928
IC201	I.C. Operational Amp. LM709C	5-113642
Q101	Transistor, Silicon, NPN, D40C1	5-118404
Q102,103	Transistor, Silicon, NPN, GET2222	5-115934
Q104,105, 106,107	Transistor, Field Effect, 2N5458	5-112747
Q108	Transistor, Silicon, NPN, 2N4274	5-113193
Q201	Transistor, Silicon, NPN, GET 2222	5-115934
Q202	Transistor, Silicon, NPN, MPS3394	5-112631
Q203	Transistor, Silicon, PNP, MPS3702	5-113864
Q204	Transistor, Silicon, PNP, 2N2907	5-116198
Q205	Transistor, Field Effect, 2N5458	5-112747
Q206	Transistor, Silicon, PNP, 2N4248	5-115484
Q301	Transistor, Silicon, NPN, MPS3394	5-112631
Q302 thru 314	Transistor, Silicon, PNP, MPS3702	5-113864
R3	Resistor, 9kΩ, ±1/10%, 1/4W	5-115492
R101,116	Resistor, 100k, ±1%, 1/2W	5-111408
R102	Resistor, 90k, ±1%, 1/4W	5-115526
R103	Resistor, 0.894μ, ±.1%, 1.25W	5-116450
R104	Resistor, 9.0Ω, ±.1%, 3/4W	5-115576
R105	Resistor, 900Ω, ±.25%, 1/4W	5-116273
R106	Resistor, 90.0Ω, ±.25%, 1/4W	5-116272
R107	Resistor, 18.0Ω, ±5%, 2W	5-119929
R108	Resistor, 56.0Ω, ±5%, 2W	5-116446
R109,149, 150,152, 156	Resistor, 270Ω, ±10%, 1/4W	5-114969
R110,157, 158	Resistor, 390Ω, ±10%, 1/4W	5-113868

R111,126 131,147, 148	Resistor, 100kΩ, ±10%, 1/4W	5-115514
R112	Resistor, 9.2 MΩ, ±2%, 1/8W	5-119288
R113	Potentiometer, 1 MEG, ±20%, 1/2W	5-118765
R114	Resistor, 2.0kΩ, ±5%, 1/4W	5-115460
R115	Resistor, 22.0Ω, ±10%, 1/4W	5-115509
R117 R119,124	Resistor, 100kΩ, ±1%, 1/4W	5-115506
R118	Resistor, 22kΩ, ±10%, 1/4W	5-113623
R135,134	Resistor, 47kΩ, ±10%, 1/4W	5-114980
R 120	Resistor, 39kΩ	5-114979
R121	Resistor, 1.0kΩ, ±1/10%, 1/4W	5-115489
R122	Resistor, 9.0kΩ, ±1/10%, 1/4W	5-115492
R123,127, 129,155	Resistor, 270kΩ, ±5%, 1/4W	5-118755
R125	Potentiometer, 100kΩ, ±10%, 1/2W	5-117692
R128	Potentiometer, 50kΩ, ±20%, 1/2W	5-118764
R130	Resistor, 100Ω, ±1%, 1/4W	5-116164
R132,133	Resistor, 10kΩ, ±10%, 1/4W	5-113624
R136	Resistor, 12kΩ, ±10%, 1/4W	5-114978
R137	Resistor, 22MEG, ±5%, 1/4W	5-118756
R138	Resistor, 1.21kΩ, ±1%, 1/4W	5-118757
R139	Resistor, 11kΩ, ±1%, 1/4W	5-118760
R140	Resistor, 2.0kΩ, ±1%, 1/4W	5-115500
R141	Resistor, 9.0kΩ, ±1%, 1/4W	5-116162
R142	Potentiometer, 500Ω, ±20%, 1/2W	5-118763
R143	Resistor, 1.50kΩ, ±1%, 1/4W	5-118758
R144,159, 162	Resistor, 47.5kΩ, ±1%, 1/4W	5-118761
R145	Resistor, 42.2k, ±1%, 1/4W	5-117504
R146	Potentiometer, 5kΩ, ±20%, 1/2W	5-118080
R151	Resistor, 30kΩ, ±5%, 1/4W	5-118753
R153	Resistor, 43kΩ, ±5%, 1/4W	5-118754
R154	Resistor, 24kΩ, ±5%, 1/4W	5-118752
R156,157, 158	Resistor, 180Ω, ±5%, 1/4W	5-116090

R160,161	Resistor, 20kΩ, ±1%, 1/4W	5-116621
R163	Potentiometer, 1kΩ, ±20%, 1/2W	5-118079
R164	Resistor, 6.73kΩ, ±1%, 1/4W	5-118759
R165	Resistor, 100kΩ, ±10%, 1/2W	5-113949
R201	Resistor, 51.0kΩ, ±5%, 1W	5-114626
R202,207	Resistor, 100Ω, ±10%, 1/4W	5-114968
R203	Resistor, 22.0kΩ, ±10%, 1/4W	5-113623
R204,205	Resistor, 10 MEGΩ, ±5%, 1/4W	5-116632
R206	Resistor, 6.8kΩ, ±10%, 1/4W	5-114976
R208	Resistor, 90.0kΩ, ±0.1%, 1/4W	5-115497
R209	Resistor, 9.96kΩ, ±0.1%, 1/4W	5-115493
R210,211	Resistor, 100kΩ, ±10%, 1/4W	5-115514
R212	Resistor, 1.5kΩ, ±10%, 1/4W	5-113872
R213,214, 215	Resistor, 10.0kΩ, ±1%, 1/4W	5-114962
R216	Resistor, 510Ω, ±1%, 1/4W	5-115488
R217	Potentiometer, 100Ω, ±20%, 1/2W	5-118762
R218,219	Resistor, 45.0kΩ, ±1%, 1/4W	5-118196
R220,221	Resistor, 2.0kΩ, ±5%, 1/4W	5-115460
R222,223	Resistor, 10.0kΩ, ±10%, 1/4W	5-113624
R301	Resistor, 3.9kΩ, ±10%, 1/4W	5-114974
R302,303	Resistor, 110Ω, ±5%, 1/4W	5-118854
R304,305, 306,307	Resistor, 1kΩ, ±10%, 1/4W	5-113871
R308	Resistor, 200Ω, ±5%, 1/4W	5-118855
R309 thru 311	Resistor, 1kΩ, ±10%, 1/4W	5-113871
R312	Resistor, 560Ω, ±5%, 1/4W	5-116094
R313 thru 319	Resistor, 100Ω, ±5%, 1/4W	5-117178
Rect.1	Diode, Bridge Rect. Woo5	5-115945
RN1	Resistor, Network	5-118781
T101	Transformer DC-DC Converter	5-118783

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PIONEER/INSTRUMENTATION INSTRUMENT LABORATORY
Div. of Pioneer-Standard Electronics, Inc.
4800 East 131st Street
Tel. 216/587 3600

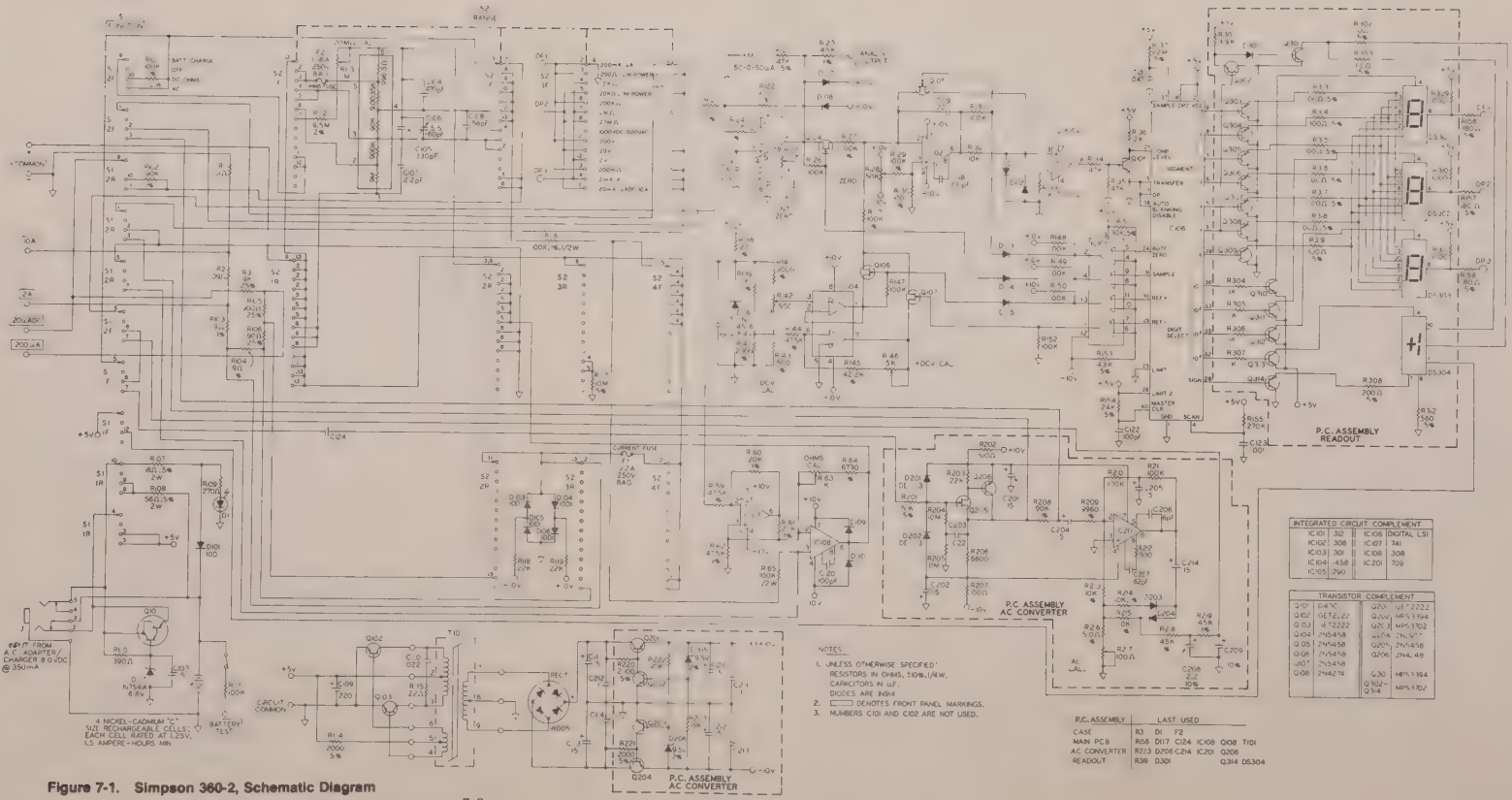
P.C. ASSEMBLY READOUT
P.C. ASSEMBLY AC CONVERTER
P.C. ASSEMBLY AC CONVERTER
4 NICKEL-CADMIUM "C" SIZE RECHARGEABLE CELLS; EACH CELL RATED AT 1.25V, 1.5 AMPERE-HOURS MIN.
CIRCUIT COMMON
BATTERY TEST
INPUT FROM A.C. ADAPTER/ CHARGER 8.0 VDC @ 350 mA
NOTES
1. UNLESS OTHERWISE SPECIFIED: RESISTORS IN OHMS, ±10%, 1/4W. CAPACITORS IN µF. DIODES ARE IN914
2. DENOTES FRONT PANEL MARKINGS.
3. NUMBERS C101 AND C102 ARE NOT USED.
INTEGRATED CIRCUIT COMPLEMENT
IC101 | 312 | IC106 | DIGITAL LSI
IC102 | 308 | IC107 | 741
IC103 | 301 | IC108 | 308
IC104 | 458 | IC201 | 709
IC105 | 390
TRANSISTOR COMPLEMENT
Q101 | D40C | Q201 | GET2222
Q102 | GET2222 | Q202 | MPS3394
Q103 | GET2222 | Q203 | MPS3702
Q104 | 2N5458 | Q204 | 2N5457
Q105 | 2N5458 | Q205 | 2N5458
Q106 | 2N5458 | Q206 | 2N4248
Q107 | 2N5458
Q108 | 2N6274 | Q301 | MPS3394
Q302-304 | MPS3702
P.C. ASSEMBLY | LAST USED
CASE | R3 D1 F2
MAIN P.C.B | R68 D117 C124 IC108 Q108 T101
AC CONVERTER | R723 D205 C214 IC201 Q206
READOUT | R39 D301 Q314 DS304

Figure 7-1. Simpson 360-2, Schematic Diagram

★★★ **OHIO, CLEVELAND 44136**
WESCHLER ELECTRIC CORP.
16900 Foltz Parkway
Tel. 216/238-2550

★★★ **OHIO, COLUMBUS 43229**
CONTRONICS, INC.
835 Busch Court
Tel. 614/846-5930

★★★ **OHIO, DAYTON 45459**
☐ E. I. L. INSTRUMENTS INC.
7915 S. Suburban Road
Tel. 513/435-2134

★★★ **OHIO, DAYTON 45424**
☐ PIONEER/DAYTON
Div. of Pioneer-Standard
Electronics, Inc.
4433 Interpoint Blvd.
Tel. 513/236-9900

★★★ **OKLAHOMA, OKLAHOMA CITY 73107**
☐ HUSTON-DEPUE LABORATORIES INC.
536 N. Pennsylvania St.
Tel. 405/235-5469

★ **OKLAHOMA, TULSA 74120**
AGRA ENGINEERING COMPANY
551 S. Quaker Avenue
Tel. 918/584-4235

★★★ **OREGON, PORTLAND 97217**
☐ WESTCON, INC.
5101 N. Interstate Ave.
Tel. 503/283-0132

★★★ **PENNSYLVANIA, PHILADELPHIA 19115**
☐ SUNSHINE SCIENTIFIC
INSTRUMENTS INC.
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620 Alpha Drive RIDC Pk.
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☐ B & C CALIBRATION
Villa Nevarez Prof. Center
GPO Box 3201 - Suite 104
Tel. 809/751-8375, 764-2260

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☐ BROWNELL ELECTRO
270 Center Park Dr.
Tel. 615/966-3441

★★★ **TENNESSEE, MEMPHIS 38118**
☐ BROWNELL-ELECTRO INC.
3821 Getwell Road
Tel. 901/795-8487

★★★ **TENNESSEE, MEMPHIS 38104**
INSTRUMENT REPAIR SERVICE
419 N. Watkins
Tel. 901/278-0762

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☐ METERS & INSTRUMENTS CORP.
6428 Gulf Freeway
Tel. 713/644-1631

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☐ QUALITY INSTRUMENT LAB INC.
4832 Caroline
Tel. 713/524-0528

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METER SERVICE & SUPPLY
2127 Kermit Hwy.
P. O. Box 2373
Tel. 915/332-0565

★★★ **TEXAS, ODESSA 79760**
☐ WHITLOCK INSTRUMENT
1306 North Texas
Tel. 915/337-3412

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E. I. L. INSTRUMENTS, INC.
5400 Cherokee Avenue
Tel. 703/354-4330

★★★ **VIRGINIA, RICHMOND 23234**
☐ INSTRUMENT TECHNICAL
REPRESENTATIVES
7400 White Pine Road
Tel. 804/275-1431

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☐ E. I. L. INSTRUMENTS, INC.
5801-A Arrowhead Dr.
Tel. 804/499-3746

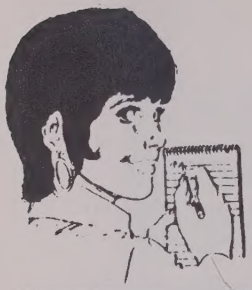
★★★ **WASHINGTON, SEATTLE 98108**
E. I. L. INSTRUMENTS, INC.
1312 S. 96th Street
Tel. 206/762-0880

★★★ **WASHINGTON, SEATTLE 98105**
☐ EICHER-RICHARDS COMPANY
2727 N. E. Blakeley Street
Tel. 206/523-7888

★★ **WASHINGTON, SPOKANE 99220**
BLACKS-INDUSTRIAL INC.
N. 401 Helena - Box 3286
Tel. 509/534-9353

★★★ **WISCONSIN, MILWAUKEE 53202**
E-M INSTRUMENTS INC.
153 No. Milwaukee Street
Tel. 414/272-7799

★★ **WYOMING, LANDER 82520**
METER SPECIALISTS, INC.
P. O. Box 595 (Mail)
Hiway 287 West (UPS)
Tel. 307/332-9711



NOTES

FOR THE RECORD

Date Purchased _____

Purchased From: _____

Identification Number: _____

Date	*Type of Service*	*Serviced By*
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Quality is the indispensable component of every Simpson instrument.....